

Enhancement of Ionization Efficiency of Hot-Cavity Ion Sources*

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Hot-cavity surface ionization sources are evaluated for applications of detecting uranium and thorium impurity levels in the high purity copper materials to be used for the experiment to search for neutrinoless double-beta-decay [1]. The performance of the ion sources is characterized using uranyl nitrate and thorium nitrate sample materials with sample sizes between 20 – 40 μ g of ²³⁸U or ²³²Th. The ionization efficiencies obtained are about 1% and 3% for U with Ta and W cavities, respectively, and 2.5% for Th with a W cavity. It has been reported that increasing the neutral density in the cavity, by feeding in a non-ionizing gas such as Xe, could increase the ionization efficiency substantially [2]. We have investigated this enhancement effect for a Ta-cavity source with Xe, Kr and Ne noble gases. It is observed that the overall ionization efficiency for U can be increased by a factor of 5 with a noble gas added and the largest enhancement is obtained with Kr. The enhancement is ascribed to the reduction of the mean free path and thus the probability of wall recombination of the ions. The characteristics of the gas effect will be reported.

References

1. N. Abgrall, et al., Advances in High Energy Physics, Vol. 2014, Article ID 365432.
2. R. Kirchner, Nucl. Instr. and Meth. A 292 (1990) 203.

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